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MEDICAL ENTOMOLOGY PROJECT

ANNUAL REPORT

Oliver S. Flint, Jr.

January 1981

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The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other governmental

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agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

Five short papers on systematics or distributions, one on Oriental *Anopheles*, three on Neotropical *Culex (Melanoconion)* and one reporting the discovery of the European *Culiseta annulata* in the United States were published during the year.

Three large monographic revisions were published during the year. These treat the Albimanus Section of the subgenus *Nyssorhynchus* of the genus *Anopheles* of the New World, the *Aedes (Stegomyia)* Scutellaris Group of Tonga and the Myzomyia Series of the *Anopheles (Cellia)* in Thailand. Four other large monographic revisions have been completed and are awaiting either review, editing, or printing. These treat the Spissipes and Ocossa Groups of *Culex (Melanoconion)* in the New World, portions of the genus *Tripteroides* of the Orient, the Argyritarsis Section of the subgenus *Nyssorhynchus* of the Neotropics and the subgenus *Paraedes* of *Aedes* of the Orient.

Research continues on the malaria vector groups of the genus *Anopheles* in the New World and Orient and on the arbovirus vector groups of the subgenus *Stegomyia*, genus *Aedes*, of the African Region. Work terminated on the arbovirus vector groups of the subgenus *Melanoconion* (genus *Culex*) of the New World.

SUMMARY

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

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TABLE OF CONTENTS

INTRODUCTION

Biosystematic studies which lead to the precise identification of vectors are fundamental to any investigation of epidemiology and to the planning of control or eradication. They enable the vector or vectors to be recognized; their ecology and habits to be studied and information about vectorial capacity, resistance to insecticides, geographic distribution and so on to be passed on to other workers. Many instances of failure to control diseases resulting from vector borne pathogens can be traced to neglect of this aspect of preventive medicine research.

The Medical Entomology Project (MEP) was developed to perform biosystematic research on medically important arthropods to meet the U.S. Army Medical Research and Development Command's requirements for accurate identification of actual or potential vectors of human pathogens throughout the world. Thus, MEP is able to respond to these needs and the resources of the project are used to accomplish these requirements. This research was accomplished by 12 contract personnel, including 3 professional entomologists, plus the principal investigator and 4 professional entomologists from Walter Reed Institute of Research (WRAIR) on assignment to MEP. In addition, upon request, MEP provides synoptic collections of specimens for the use of various military entomologists and assists them in biosystematic studies of medically important arthropods. This level of support may range from furnishing entomologists with keys, necessary literature, and other identification guides to the loan of specialized collecting and rearing equipment which cannot be obtained from other sources. Such support has proven invaluable to all concerned, as the Smithsonian Institution has received extremely worthwhile material from these entomologists.

REVIEW OF PROGRESS FOR THE PERIOD
1 January to 31 December 1980

1. Biosystematic Studies on Culicidae

a. Genus *Anopheles*

(1) Subgenus *Cellia* (Leucosphyrus Group) of the Oriental region (E. L. Peyton). Research in collaboration with the U. S. Army Medical Component, Armed Forces Research Institute of Medical Sciences (AFRIMS), Bangkok, Thailand, has continued on the revision of the Leucosphyrus Group of *Anopheles (Cellia)*. Considerable progress has been made in resolving a number of very complex problems within the Balabacensis Complex and among other members of the group. These problems have been discussed in detail in previous reports. Essentially, they involve the recognition of several geographic forms of *balabacensis* that exhibit small morphological differences in one or more life stages, while intraspecifically exhibiting considerable variation and some character overlap. From the outset it seemed probable that a few of these forms represented distinct unnamed species while others were merely variants of known species. Since the adult stage of some show no apparent consistent morphological differences, and the immature stages occasionally exhibit variations that could not always be correlated with recognized adult differences, it was difficult to determine the value of each taxonomic character. At times the task seemed almost insurmountable, especially in constructing workable keys for the separation of the various life stages of each taxa. In view of the medical significance of the group and the obvious difficulties resulting from the lack of identification keys for workers and investigators in the field, we have been very cautious in our approach to recognizing new taxa. In each case we have attempted to confirm the status of the taxa in question through laboratory hybridization studies and cytogenetic studies at the AFRIMS laboratory before formally recognizing it as a species or subspecies.

During the year, 1,800 additional specimens of the Leucosphyrus Group were received from the AFRIMS for study. Most of the collections were from two important provinces of Thailand, Kanchanaburi and Phangnga, where the Fraser's Hill form of *balabacensis* is known to occur. The site in Kanchanaburi is west of Bangkok along the eastern slope of the Bilauk Taung Range on the Khwae Noi river, and the Phangnga site is along the western coast of the southern peninsula, approximately 650 km south of the Kanchanaburi site. Included among these collections were the first progeny rearings of the Fraser's Hill form, plus numerous individually reared associated specimens of the Fraser's Hill form, *dirus* and *leucosphyrus*. These collections afforded the first opportunity to evaluate the morphological variation within a progeny series and among sympatric populations of the three species.

Comparative morphological analysis of collections from many different localities and habitats was made of the species within the complex. Data on adult characters, and larval and pupal setal branching was recorded for

each species from various geographic localities. This procedure was followed for a much larger sample than is customary for the treatment of most species because of the great similarity among species and the need to establish statistically significant morphological differences. The data on each taxonomically important character was compared and analyzed as to frequency of occurrence and trends in character variation. From this it now seems clear that many of the variations noted in some species represent a north-south cline. This is exhibited most strongly in the adults of the Fraser's Hill form, and in *leucosphyrus*, in the pupa of *dirus*, and, to a lesser degree, in the pupa of Fraser's Hill form and the larva of *dirus*. Many other interpopulational variations appear random and of a relatively low frequency in any given area. The following presents a few examples. The adults of Fraser's Hill form in the northern part of their range have a narrow, but quite prominent, basal white band on hindtarsomere 4, and the presector dark spot on the radius of the wing has 2 to 3 distinct pale spots along its length. At the southern end of its range the pale band on hindtarsomere 4 is absent, and the pale interruptions on the presector dark spot are reduced in number with a fair percentage of specimens showing none. Since these are characters used to distinguish other species in this area (such as *introlatus* and *leucosphyrus*, both without basal pale bands on hindtarsomere 4, and *macarthuri* without a pale band on hindtarsomere 4 and without pale interruptions on the presector dark of radius), recognition of adults without associated immature stages becomes more difficult. The immature stages of *dirus* exhibit 2 significant variations. In the pupa of *dirus* a sensitive character for the separation of *dirus* from the Perlis form is the length of spine 9-IV and the ratio of 9-IV/V. Populations of *dirus* north of the Isthmus of Kra are readily separated from the northern Malayan Perlis form by this character alone. However, south of the isthmus, this character in *dirus* gradually changes with a higher percentage of specimens exhibiting a Perlis form-like condition, and where *dirus* and the Perlis form occur sympatrically near the northern Malayan border, there are no differences in this character. Since the adults of these latter 2 are apparently inseparable, recognition becomes extremely difficult. Laboratory hybridization and cytogenetic studies at AFRIMS have clearly demonstrated that these 2 are distinct species. In addition, several larval collections of *dirus* from the Khwae Noi valley of Kanchanaburi exhibit characters quite unlike those of specimens from all other parts of its range; these larvae are very similar to the distinctive larvae of the Fraser's Hill form. These collections were all made from rock pools; several other collections of typical *dirus* and Fraser's Hill form were made in the same general area but from the more typical ground pool habitat. Atypical larvae of *dirus* have been encountered only in this valley. Although initially it appeared that these might represent an additional distinct isolated member of the complex, a thorough study of all the stages of the specimens from this area suggest that they are *dirus*, and the variations noted in the larva is the result of some unknown environmental factor of the rock pool habitat. A similar clinal problem occurs with wing characters of *leucosphyrus*. One of the distinguishing adult characters of *leucosphyrus* from Sumatra (type locality), Borneo and peninsula Malaysia is the presence of a well developed accessory sector pale spot on the costa of the wing, but this spot tends to disappear as the species extends north into Thailand, and resembles the wing of *dirus* and the Perlis form in this character.

With the above points in mind, a new preliminary key to the various stages was prepared and is currently being field tested by AFRIMS personnel. Changes and refinements in the key are being made based on field trials and further findings at MEP. It now appears that the construction of identification keys is possible, but for some species, particular stages will have to "key" out in two or more couplets. A revised key is now in preparation.

With all the material examined in detail and the nature of some of the more perplexing variations better understood, the task of defining each species can continue. Considerable preliminary work has been completed on the Fraser's Hill and Perlis forms, and a manuscript describing these will be ready for publication during 1981 (coauthored with LTC Bruce A. Harrison of AFRIMS and Dr. Shivaji Ramalingam of the University of Malaysia). In collaboration with LTC Harrison, another paper describing and illustrating *takasagoensis* from Taiwan was published in the September 1980 issue of "Mosquito Systematics." Prior to this study, this species had been considered a synonym of *balabacensis*. The publication of papers on the Fraser's Hill and Perlis forms will complete the treatment of the unnamed forms of the Balabacensis Complex from Malaysia and Thailand.

A collection of adults and associated immature stages of 2 species from southern Sumatra, Indonesia were sent by Dr. Shivaji Ramalingam, through AFRIMS, to MEP in late 1980. These were thought to be the Fraser's Hill form because of the close resemblance of the larvae. Upon detailed examination, most of the material proved to be a new species unrelated to the Fraser's Hill form in the Balabacensis Complex. It belongs to a separate subgroup containing *elegans, hackeri, pujutensis* and *sulawesi*. The discovery of this new species has aided in the hypothesis of phylogenetic relationships within the Leucosphyrus Group and the attempt to develop a natural classification based on derived characters. The group can be divided into 3 distinct, as yet unnamed, subgroups. The new Sumatran species will be described during the coming year in collaboration with Dr. Ramalingam. A few remaining adults from the Sumatra collections proved to be *balabacensis introlatus*. This represent the first known record of the subspecies (will be elevated to full species status in the forthcoming revision) beyond the Malay Peninsula.

In addition to the above studies this investigator critically reviewed 4 manuscripts written by others.

Illustrations were completed for the pupa and larva of most species in the Leucosphyrus Group, several drawings of other stages or structures were drawn.

To illustrate the close similarity of species within the Balabacensis Complex and the difficulty of defining differences, the discussion section appearing in the recent paper by Peyton and Harrison describing *takasagoensis* from Taiwan is reproduced here.

> Morphologically, *takasagoensis* is very similar to *balabacensis* and *dirus*, but we have found small, fairly consistent differences in the adult, pupal and larval stages that are sufficient to separate the former

from both species. Morphologically, it is closest to *dirus* and differs from *balabacensis* in several of the characters used in Peyton and Harrison (1979) to separate *dirus* from *balabacensis*. In addition to morphological evidence, reciprocal cross-mating experiments between *dirus* and *takasagoensis* provided biological and cytogenetic evidence to support the elevation of *takasagoensis* to specific status.

Although all of the presently recognized species of the Balabacensis Complex are extremely similar in all stages, *takasagoensis* morphologically, shows the greatest affinity to *dirus*. The wing of the adult female of *takasagoensis* differs from that of *balabacensis* primarily in the absence of an accessory sector pale spot (ASP) on veins C and Sc. In this respect, it is similar to *dirus* and most other mainland taxa of the complex. The presector dark spot (PSD) of vein R is more like that of *balabacensis* with most specimens showing no basal extension of this spot beyond the corresponding dark spot on C or, if there is a slight extension, it rarely reaches beyond the middle of PSP of C. On the wings of *takasagoensis* females the SCP spot of C is usually longer than the PP spot of C on both wings (39/48) or on at least one wing (45/48) and with only 2/48 actually shorter than PP on one wing only. In females of *dirus* on C the SCP spot is 0.44-1.50 the length of PP spot and is usually shorter than the PP spot on both wings (31/68) or on at least one wing (53/68), but 7/68 had the SCP spot longer than PP spot on both wings and 16/68 had it longer on at least one wing. A small percentage of specimens of both species have the 2 spots equal on one or both wings. This character is of little value in species identification of single specimens, but, in combination with the absence of a basal extension of the PSD spot of R, it becomes more useful and should prove to be of greater importance in recognizing different populations. Most other characters in the adult of both species are more variable with a higher degree of character overlap.

Anopheles takasagoensis is most easily distinguished from *dirus*, *balabacensis* and most other species of the Leucosphyrus Group in the pupal stage. Seta 9-IV of *takasagoensis* is of the short type and in this respect, very similar to *dirus*. Seta 1-V-VII is single in *takasagoensis*, whereas in *dirus* and *balabacensis* it is never single on all 3 segments. In *dirus* 1-V-VII is branched as follows: 1-V 2-4 branched, rarely (1/45) single, 1-VI single to 3 branched, rarely (2/45) single on both sides and occasionally (12/45) single only on one side, 1-VII single to 3 branched, occasionally (13/45) single on both sides, and when single on both sides, 1-V,VI always branched. In *balabacensis* this seta is: 1-V 2-5 branched, rarely (1/30) double on both sides and occasionally (4/30) double on one side only, 1-VI 2-4 branched and 1-VII single or double in about equal frequency.

The larva of *takasagoensis* is very similar to that of *dirus* and *balabacensis* and differs from both primarily in the length and placement of seta 4-C (Fig. 2), and from *balabacensis* in the weakly developed seta 1-II. The length of 4-C is shorter than that of either *dirus*

or *balabacensis* and this, combined with the usually greater distance separating the insertions of 2-C and 4-C, gives it an even shorter appearance. The length of 4-C in *takasagoensis* is 0.044-0.072 mm with mean length of 0.062 mm. In *dirus* the length of 4-C is 0.062-0.091 mm with mean length of 0.077 mm. The distances between the insertions of 2-C and 4-C in *takasagoensis* and *dirus* are 0.084-0.111 mm ($\bar{X}$=0.100 mm) and 0.058-0.099 ($\bar{X}$=0.080 mm), respectively. The ratio of the length of 4-C to this distance is usually expressed as the distance 4-C extends forward divided by the distance between the insertions of 2-C and 4-C. In *takasagoensis* and *dirus* 4-C extends forward 0.46-0.76 ($\bar{X}$=0.63) and 0.69-1.29 ($\bar{X}$=0.97) the distance between the insertions of 2-C and 4-C, respectively. The length of 4-C and distance between the insertions of 2-C and 4-C in *balabacensis* is similar to that of *dirus*. In both *dirus* and *balabacensis* 4-C usually extends to very near or beyond the insertion of 2-C, while that of *takasagoensis* falls considerably short of the insertion of 2-C. Seta 4-C in *takasagoensis* is often branched at or near the middle while the other 2 species often have 4-C bifurcated near the apex. The above measurements were made from mounted skins that were determined to be without tears or noticeable distortions, and with seta 4-C extended and close to one focal plane; even so, measurements should be viewed as approximations only.

(2) Subgenus *Anopheles* (Arribalzagia Group) of the Neotropical Region (George K. Bryce). During the report period work continued on a revision of the Arribalzagia Group of the subgenus *Anopheles*. This revision will include the following species: *apicimacula, gabaldoni, intermedius, mattogrossensis, mediopunctatus, minor, neomaculipalpus, peryassui, punctimacula, shannoni* and *vestitipennis*. It will also include a discussion of the recently described *veruslanei* Vargas, 1979. These species will be considered in this revision since there is some material of each available and because of the medical importance of certain ones.

To date, descriptions have been written for all the larvae and male genitalia, and for the pupae of eight species. The adult females have been studied in detail and tables prepared showing scale patterns, etc., for the various species. The bionomics, medical importance and distribution sections for each species have been completed. Preliminary keys of the male genitalia and larvae have been prepared. Because of the untimely death of Dr. John N. Belkin and the lack of financial support, it is impossible to predict a completion date for this revision.

(3) Subgenus *Nyssorhynchus* of the Neotropical Region.

(a) Albimanus Section (M. E. Faran). The revision of the Albimanus Section of the subgenus *Nyssorhynchus* was published in March 1980. In conjunction with this revision, a paper entitled "The synonymy of *Anopheles (Nyssorhynchus) noroestensis* with *An. (Nys.) evansi* with a description of the lectotype of *An. evansi*," was submitted to "Mosquito Systematics" to be published in the December 1980 issue.

(b) *Nyssorhynchus* of Amazonia (M. E. Faran and K. J. Linthicum). The final draft of the illustrated handbook on the species of *Nyssorhynchus* occurring in Amazonia has been typed, edited and reviewed for publication, which is scheduled for early 1981. This handbook will be approximately 80 pages in length and will include 164 illustrations. The illustrations for this handbook were completed during this period. This handbook will facilitate identification of the numerous morphologically similar species in this subgenus, and provide a brief discussion of the bionomics, medical importance and distribution of each species.

(c) Cytogenetic Studies (K. J. Linthicum). The cytogenetic study of 8 geographic strains of *Anopheles (Nyssorhynchus) albimanus* nears completion. The publication of the descriptions of the ovarian nurse cell polytene chromosomes is anticipated in 1981.

(d) Argyritarsis Section (K. J. Linthicum). The final editing of the revision of the Argyritarsis Section of the subgenus *Nyssorhynchus* continued and is nearing completion. This monograph will be approximately 200 pages in length and will include descriptions, discussions of bionomics and medical importance, keys, and illustrations for the 8 species included in the Section. It is based on the study of approximately 9,000 specimens: 1,500 males, 3,800 females, 3,000 larvae, and 700 pupae, including 526 individual rearings (268 larval, 226 pupal and 32 incomplete) and 15 progeny rearings. All distribution and collection record information for the specimens examined in the revision have been incorporated into the final draft. It is anticipated that the final draft will be typed and published in late 1981.

b. Genus *Aedes*, subgenus *Stegomyia*

(1) Subgenus *Stegomyia* of the South Pacific (Y.-M. Huang). A revision of the *Aedes scutellaris* group of Tonga by Huang and Hitchcock was published in 1980. It is based on the examination of more than 9,000 specimens (including 1,866 individual rearings with associated pupal and/or larval skins) of 3 species and one subspecies. The group is defined and keys to the identification of the species of the group in the Fiji-Tonga-Samoa area are provided and their geographical ranges presented. The known stages of 3 species and one subspecies in Tonga are described or redescribed and illustrated and information on type-data, distribution, bionomics, medical importance and a taxonomic discussion are presented.

The information on the bionomics and medical importance of the above species and subspecies is based on field studies conducted by James C. Hitchcock in Tonga from 1968-73. Special emphasis is placed upon immature habitats, relative abundance of each member of the group, composition of associated invertebrate fauna, biting behavior, fecundity and gonotropic cycle. The role of the Scutellaris Group in the transmission of filariasis and dengue viruses in Tonga is discussed.

(2) Subgenus *Stegomyia* of the African Region (Y.-M. Huang). A combined African museums, field study and training trip to Kenya, South Africa and Nigeria was taken from January 1 to March 29, 1980. Three African museums were visited. The collection at the Division of Vector-Borne Diseases, Ministry of Health, Nairobi, Kenya, was studied. Time only allowed for half of the *Stegomyia* material to be identified and the data recorded. However, some of the most important material was borrowed for further study here. The South African Institute for Medical Research (SAIMR) and the National Institute for Virology both in Johannesburg, South Africa were visited. All the collections, including types were carefully studied and identified, data recorded, and important material was selected for loan.

Five locations in northern and eastern Transvaal, northeastern Natal, and southeastern Cape Province were visited for the purposes of field collections. A total of 73 collections were made, from which 12 species of *Aedes (Stegomyia)* were reared including a new species, and *bromeliae*, a new record for South Africa. Individual rearings were also made of *Anopheles* species of the Gambiae Complex. An additional 20 lots of eggs were obtained from bamboo pots placed in the field, which were reared at the MEP laboratory during early April to late June, 1980.

A very important adjunct to my work was the training of local workers in methods and techniques of collecting, individual rearing with preservation of associated larval and pupal skins, preparation of specimens for taxonomic study and recording field data as well as identification of mosquitoes. This will enable them to collect specimens and obtain adequate material for the project in the future. Not only did I give lectures everywhere I went, but in South Africa I was accompanied in the field by trainees. As a result of all this effort we can be assured of future willing cooperation and a steady flow of material.

As a result of the African studies, a manuscript with illustrations on a new species of African *Stegomyia* closely related to the *Aedes calceatus* Edwards has been completed and submitted for publication. It is anticipated that this paper will be published in the December (1980) issue of Mosquito Systematics. In addition, a preliminary study of the following species related to *Aedes calceatus* and the new species was completed: *contiguus* Edwards, *langata* Van Someren, *poweri* Theobald and *soleatus* Edwards. Current work on the South African *Stegomyia* specimens which were collected during my field trip should resolve some taxonomic problems related to the species pairs *simpsoni* (Theobald) - *bromeliae* (Theobald), *demeilloni* Edwards - *heischi* Van Someren, and *aegypti* (Linnaeus) - ssp. *formosus* (Walker).

During the year new material consisting of 152 adults (including 30 individual rearings with associated larval and pupal skins) of African *Stegomyia* were acquired from the following sources: (1) 73 adults, 30 larval and pupal skins and 6 whole larvae, (Uganda), from Dr. L. G. Mukwaya, Uganda Virus Research Institute, Uganda; (2) 28 adults, (South Africa), from Mr. D. Eckard, National Institute for Tropical Diseases (NITD), South Africa; (3) 3 adults, (Angola), from Prof. H. Ribeiro and Dr. H. da Cunha Ramos,

Instituto de Higiene e Medicina Tropical, Lisboa, Portugal; (4) 48 adults, (Senegal), from Dr. T. H. G. Aitken, School of Medicine, Yale University, U.S.A.

Eight lots of eggs, (South Africa), from Mr. J. Muspratt, SAIMR and Mr. E. J. Jansen, NITD, South Africa, were received and hatched at MEP. Individual rearings were carried out and the adult specimens with their associated larval and pupal skins were prepared at MEP for taxonomic studies. A total of 681 adults with larval and/or pupal skins were obtained by this method during this year.

(3) Subgenus *Paraedes* of the Orient (J. F. Reinert). Work initiated and supported at MEP by J. F. Reinert when he was stationed here has come to fruition with the completion of a revision of the subgenus *Paraedes*. The subgenus includes 8 currently recognized species, all restricted to the Oriental Region. All known stages of each species are described and illustrated, and keys are presented. Geographical distributions, bionomics, type-data and taxonomic discussions are given for each species.

c. Genus *Culex*

(1) Subgenus *Melanoconion* of the Neotropical Region (S. Sirivanakarn). This project was supported by MEP for the first 6 months of the year. During this time work on the Spissipes and Ocossa groups of the subgenus *Melanoconion* was completed and is awaiting review and editing. Three smaller papers, two leading directly to the revision, were completed and published during this period.

In the first paper with Dr. J. N. Belkin as co-author, corrections and taxonomic changes are made in the interpretation of the following nominal taxa: *opisthopus* is synonymized with *taeniopus*, *pseudotaeniopus* is synonymized with *epanastasis*, *crybda* is considered valid and is resurrected from synonymy of *epanastasis* and a new species, *pedroi*, is described for the Panamanian population previously referred to as "*taeniopus*." In the second paper, *C. adamesi*, a new species related to *crybda* and *epanastasis*, is described in collaboration with Dr. Pedro Galindo for the Panamanian form previously recorded as "type G" (Galindo 1969, Mosq. Syst. Newslett. 1:82-9). The third paper, written jointly with Sandra J. Heinemann, establishes the identity of *C. simulator* Dyar and Knab, originally described from a larva only. Reared material permitted the full description of all stages of this species for the first time.

The revision of the Spissipes and Ocossa Groups is a synthesis of the data on the systematics, distribution, and bionomics with a summary of known medical importance of the species in these groups of the Neotropical subgenus *Melanoconion*. For this study 4,460 specimens (2,053 females, 1,891 males, 41 pupae, 375 larvae, 51 pupal skins, 49 larval skins) were examined. Included in this material are 681 adults with associated larval and/or pupal exuvia obtained from individual field rearings and 101 adults from progeny-mass rearings.

Sixteeen species and one unnamed form are recognized and described. The descriptions of 11 species are based on all stages (female, male, pupal and larval), that of 5 other species are based only on the males, and 1 species is based on the male and a presumptive female. Fourteen species and one unnamed form [*spissipes* (Theobald 1903), *taeniopus* Dyar and Knab 1907, *vomerifer* Komp 1932, *portesi* Senevet and Abonnenc 1941, a new species from Brazil, *pedroi* Sirivanakarn and Belkin 1980, *crybda* Dyar 1924, *adamesi* Sirivanakarn and Galindo 1980, Brazil form (unnamed), *epanastasis* Dyar 1922, *paracrybda* Komp 1936, *delpontei* Duret 1969, *pereyrai* Duret 1967, *lopesi* Sirivanakarn and Jakob 1979, *faurani* Duret 1968] are classified into 6 subgroups of the Spissipes Group, and 2 species (*ocossa* Dyar and Knab 1919 and *panocossa* Dyar 1923) are assigned to the Ocossa Group. Keys to the known stages for the subgroups and species are provided. Illustrations of all stages of the species representative of each subgroup or group are presented in full; illustrations of the remaining species are restricted to the figures of the male genitalia and/or other significant diagnostic features showing pertinent details only. Supplemental to conventional line drawings are scanning electron micrographs of certain diagnostic features of the adult that could not be accurately described or figured in detail.

(2) Subgenus *Culex*, *pipiens* Complex

(a) Biosystematics (R. E. Harbach). Biosystematic research was initiated on the Pipiens Complex with particular emphasis on Egyptian forms. All of the Pipiens material in the USNM was assembled, and preliminary comparative morphological study of the pupal stages of *molestus* (Egypt and Japan), *pipiens* (U.S.A.), *quinquefasciatus* (U.S.A., type locality), and *pallens* (Japan), using the light and scanning electron microscopes, was begun. Detailed study of the chaetotaxy of the pupae are underway; preliminary pencil drawings of Eygptian *Cx. molestus* currently are in preparation.

An extensive literature survey on all members of the complex was started, and synonymy and morphological data files were established. The literature search will lead to the development of a computer-based bibliography.

Progeny from a single egg raft of *Cx. quinquefasciatus* collected in Malibu, California was provided by Dr. A. Ralph Barr, University of California at Los Angeles. From this, 26 pupae and 77 larvae were individually reared. Sixteen egg rafts (F_1 generation) of Egyptian *Cx. pipiens* were received from MAJ C. L. Bailey, Department of Arboviral Entomology, USAMRIID, Fort Detrick. The eggs were hatched and the progeny individually reared. Over 300 adults with associated larval and pupal skins were obtained and prepared for taxonomic study.

Hybrid larvae that resulted from crossbreeding experiments made between 2 strains of *pipiens* from Egypt (Qaliyaubiya and Ismailiya), and between one Egyptian (Qaliyubiya) and 2 North American strains (Fort Mott, NJ and Fort Washington, MD) were also received from USAMRIID and individually reared. From this material, about 100 fourth stage larvae and 300 pinned adults with associated larval and pupal skins were retained for study. The remaining adults

were transported live to Walter Reed Army Institute of Research where they were backcrossed to the parent strains. Egg rafts resulting from the backcrosses were examined and the number of unembryonated, embryonated unhatched and hatched eggs were counted. There was no indication of partial incompatibility. Resultant larvae were removed to MEP and are being reared at the time of this writing. A portion of the fourth stage larvae will be individually reared for taxonomic investigation; the remainder will be mass reared.

Egg rafts from laboratory strains of *pipiens* originating at Ft. Mott and Ft. Washington (courtesy of USAMRIID) were hatched and reared at MEP. Individual progeny of this material yielded a total of 95 adults and 126 larval and/or pupal skins. In addition, 10 larvae of each stage of both strains were preserved in ethanol for future mounting and study.

About 70 slide mounts have been prepared of the male genitalia of Egyptian and North American *pipiens*. Seven manuscripts were critically reviewed for publication in scientific journals. In addition, the index for the book "Taxonomists' Glossary of Mosquito Anatomy" was prepared during this period.

(b) Electrophoretic Isozyme Analysis (K. J. Linthicum). Research to explore the feasibility of using electrophoretic isozyme analysis of *Culex pipiens* as a means of determining systematic differences between populations was initiated. This work is in direct support of the foregoing comparative morphological studies regarding this species.

(c) Winter survival (M. E. Faran, C. L. Bailey, and T. Gargan). A rough draft of a paper was completed on the winter survival and ovarian development of *Culex pipiens* in the eastern U.S., which includes a mathematical model that predicts overwintering survival of diapausing adult females.

d. Genus *Culiseta*

(1) Discovery of *C. annulata* (M. E. Faran and C. L. Bailey). A short paper reporting the discovery of an overwintering adult female of the European species, *Culiseta annulata* (Schrank) in Baltimore, Maryland, was published in the June 1980 issue of "Mosquito News." The single female was found on 8 March 1978, resting on a wall inside "Outer Battery Bomb Proof No. 2" at Fort McHenry National Monument and Historic Shrine, Baltimore. Because of this species' ability to inhabit diverse aquatic environments and to overwinter as an adult female (or immature, climate permitting), it is possible that a specimen could easily have survived a transatlantic voyage protected in any number of places aboard a ship. Since many large freighters do moor at docks adjacent to, or very near, Ft. McHenry, it is most likely that this specimen or one of its ancestors was introduced into the Ft. McHenry-Baltimore area by a ship traveling from Europe. As the specimen was in good condition, it is possible that a breeding population of *annulata* has been established in the vicinity of Ft. McHenry, and this specimen did not simply ride aboard a ship as an adult, then find its way into the bunker.

2. Field Studies

a. Africa

A combined African museum and field study trip was taken by Dr. Yiau-Min Huang between January 1-March 1980. The purpose of the trip was (a) to study type-specimens and other important existing material of African *Stegomyia* and to arrange for the loan of the material in the African museums, (b) to undertake field studies in South Africa and (c) to help train local workers in rearing techniques and to give a course at the WHO Center in Enugu, Nigeria.

(a) African museums

Three African museums, (1) Division of Vector-Borne Diseases (DVBD), Ministry of Health, Nairobi, Kenya (January 3-12 and March 17-20), (2) Department of Medical Entomology, the South African Institute for Medical Research (SAIMR), Johannesburg and (3) the National Institute for Virology (NIV), Johannesburg, South Africa (January 14-31), were visited. Two primary types of African *Stegomyia* were studied at SAIMR and notes on the taxonomic characters and type-data were taken for these and other important specimens. Although all the specimens in South Africa were identified and data recorded, time allowed only half of the collection in Nairobi to be studied, but important material was selected for loan. A total of 172 adult specimens, including 1 holotype specimen (86 adults from DVBD, 47 adults from SAIMR, and 39 adults from NIV) were hand-carried back on loan from this trip. Most of the specimens were from South and East Africa.

(b) Field studies in South Africa (February 1-March 15)

The objectives of this field work were: (1) to collect and rear mosquitoes and to obtain biological and ecological data for a study of the African mosquitoes, particularly topotypic and other critical material of *Aedes (Stegomyia)* and *Anopheles* (especially members of the *gambiae* complex) which are presently considered the most valuable to MEP for research purposes, and (2) to train local field workers in methods and techniques of collecting, individual rearing with preservation of associated larval and pupal skins, preparation of mosquito specimens for taxonomic study and recording field data. This will enable them to collect specimens and obtain adequate material for the Project. With the cooperation of Dr. John A. Ledger (SAIMR) in Johannesburg, Dr. C. F. Hansford and his entomologists of the National Institute for Tropical Diseases, in Tzaneen, Eshowe, Jozini, and Dr. Moosa A. Motara of Rhodes University, in Grahamstown, the above 5 locations were chosen for the centers of field studies. Fourty-four days were spent in the field in South Africa, covering the northern and eastern parts of Transvaal, most of the eastern part of Natal and the southeast part of Cape Province.

Since most species of *Aedes (Stegomyia)* breed mainly in temporary, natural and artificial containers (such as tree holes, bamboo stumps, leaf axils, tin cans, and tires) and the *Anopheles gambiae* complex are temporary ground pool breeders, the collections were concentrated on these types of breeding habitats. Locality and ecological data have been recorded on standard collection forms and are on file with the MEP collection. A special effort was made to collect

immatures, particularly larvae, in the natural habitat and to carry out individual rearings thus obtaining adults with associated larval and pupal skins which are essential in clarifying the true identity of the species as well as in resolving species complexes.

Although the field trip was taken during the rainy season, it was, unfortunately, very dry this year. Therefore, it was difficult to collect tree hole and leaf axil breeders such as *Aedes (Stegomyia)*. Bamboo and wooden pots were put out in the forests throughout the collecting areas as oviposition traps to obtain eggs. In addition, eggs from a single female biting man were obtained, and progeny rearings were carried out. A total of 20 lots of eggs (6 from individual females, and 14 from bamboo pots) were obtained and brought back to MEP and individual rearings were carried out here.

A total of 73 collections were made. Twelve species of *Aedes (Stegomyia)* were collected, of which 1 species, *bromeliae* (Theobald), is a new record for South Africa. At present, there are 15 species of *Aedes (Stegomyia)* which have been reported from South Africa. A total of 1971 adults with associated larval and/or pupal skins, belonging to 5 genera *(Anopheles, Aedes, Culex, Eretmapodites* and *Toxorhynchites)*, were obtained. All the adults have been identified and sorted to genus, subgenus or species. At least 85% of the total collected material are *Aedes (Stegomyia)* and *Anopheles* with a good series of all stages represented for most.

(c) Training work

While in South Africa, demonstration courses on the methods and techniques of collecting, individual rearing with preservation of associated larval and pupal skins, preparation of mosquito specimens for taxonomic study and recording field data were given at (1) SAIMR, Johannesburg, for SAIMR staff, (2) NITD, Tzaneen, for NITD staff, (3) NITD, Eshowe, for NITD staff and Richards Bay Town Board, Ministry of Health, Entomologists, (4) Rhodes University, Grahamstown, for Dr. Motara and his students. While in Nairobi, Kenya, I was asked by Dr. J. M. D. Roberts, Director, DVBD, and his Senior Entomologist, Mrs. Phoebe A. O. Josiah, to give a demonstration course in the laboratory on the preservation and mounting of adult mosquitoes to their staff and students.

At no expense to MEP a stop-over was arranged in Nigeria from March 20-29, 1980. This was an invitation of the World Health Organization to participate in a training course on Yellow Fever Vectors at the National Arbovirus and Vectors Research Unit, Enugu, Nigeria, for the purpose of training local field workers such as entomologists, ecologists, public health inspectors and laboratory technicians, in the methods of collection, preservation, morphology and diagnostic characters, and the use of keys for identification of yellow fever vectors. Fifteen students (local field workers) from the National Arbovirus and Vectors Research Unit, the Institute of Management and Technology, the Malaria and Vector Research Unit, all in Enugu, the University of Nigeria, Nsukka and the University of Ibadan, attended the course. The courses were very successful.

b. Brazil

S. Sirivanakarn at no expense to MEP and on his own time completed a short museum and field trip to Brazil from January 11 to 27, 1980. While in Rio de Janeiro he studied material at the Museu Nacional and the Instituto Oswaldo Cruz, then moving to Sao Paulo, the collection at the Instituto Adolfo Lutz and School of Public Health, University of Sao Paulo were seen. Useful material, including 6 types of Anduze, was found in these collections and valuable notes were taken. A five day field trip in the State of Sao Paulo with members from the Instituto Adolfo Lutz resulted in the collection of *Culex (Mel.) ocossa* and other valuable material for MEP in exchange for training of local personnel in current collecting and rearing techniques.

Information and material gained on this trip were invaluable for the completion of the revision of the Spissipes and Ocossa Groups of *Culex (Melanoconion)*.

3. Curatorial Activities

a. Status of World Collection of Culicidae

Efforts to amalgamate the Belkin, CDC and "Excess" collections with the existing museum collection and upgrade its curatorial status was hampered by lack of supplies early in the year and halted by the reduction in personnel for the last half year. However, the genus *Culiseta* was completely reworked. This involved the handling of about 4,500 specimens.

Dr. John N. Belkin left his entire collection of mosquitoes and library to the Smithsonian Institution. The collection above amounts to some 5,120 slide boxes and 948 insect drawers. Plans were finalized in the last days of 1980 for its packing and delivery early in 1981. His collection is strongest in individually reared material from Latin America, where the National Collection is weak, thus, after the amalgamation of the collections, MEP will have available the best collections in the world for the New World and Oriental fauna.

Dr. William E. Bickley (University of Maryland) has continued working in the project a few days each week identifying and curating North American mosquitoes of the genus *Aedes*.

b. Accessions and Other Activities of the MEP Collections Management Section

The 56 accessions received by MEP are summarized in Appendix 1. During 1980 these totaled 9,751 specimens.

During the year 101 egg lots were reared to produce approximately 1,800 adults with associated larval and pupal skins. The approximately 6,000

specimens of *Tripteroides* on loan to Dr. Mattingly were returned in six large boxes. The material is determined and after final labeling will be reincorporated into the collection.

Outgoing material involving specimens (loans, return of borrowed material, etc.), accounted for 1,462 specimens in 37 transactions.

4. Other Activities

a. Identification Services

In keeping with the stated duties at MEP, the staff made or arranged to have made several identifications of material from outside sources. Most of these involved small lots of mosquitoes and other insects from the following sources: CDC, U.S. Public Health Service; World Health Organization; Pan American Health Organization; USAID; USDA and Notre Dame University.

b. Publications

Five short papers and three large monographic revisions were published during the year (appendix 2).

The monograph by Huang and Hitchcock "A revision of the *Aedes scutellaris* group of Tonga (Diptera: Culicidae)," which is summarized in this report in section 1b(1) on page 7, is basically a MEP product. The other two revisions, one by Faran "A revision of the Albimanus Section of the subgenus *Nyssorhynchus* of *Anopheles*," and the other by Harrison "The Myzomyia Series of *Anopheles (Cellia)* in Thailand, with emphasis on intraspecific variations (Diptera: Culicidae)" were supported in a great part by MEP. Their review, editing, final typing, publication and distribution, as well as partial illustrative support, and access to the collections were all provided by MEP. Not being summarized elsewhere, they are here abstracted.

The Harrison monograph is a comprehensive revision of the Myzomyia Series of *Anopheles (Cellia)* in Thailand, with a discussion of the other species in the series from the Oriental faunal region. Over 36,000 specimens of 11 species were examined and studied for morphological variations. Included are 23 plates of illustrations of pupae, 4th-stage larvae, male genitalia, and adult female and numerous drawings of the scutum, wing, proboscis and palpus, including variations, for the 6 species in Thailand. Major sections included are: zoogeographic considerations; methods; format; keys to the subgenera and series of the subgenus *Cellia* in Thailand; the Myzomyia Series in the Ethiopian, Palearctic and Oriental faunal regions with keys, and a discussion of the 5 Oriental species not found in Thailand; the Myzomyia Series in Thailand with keys, historical review, medical significance and descriptions of the species; hybridization experiments and appendices. Species descriptions include sections on: synonymy; diagnosis; descriptions of female, male, pupa, 4th-stage larva and egg; type-data; distribution; variations; taxonomic discussion and bionomics. Seven tables on adult variations and adult biting behavior are

included in the text and 12 tables on pupal and 4th stage larval setal branching variations are included as appendices.

The type-specimens or type-series for 17 nominal taxa were located and examined. The location of several types is corrected. The pupae of *pampanai* and *varuna* are described and illustrated for the first time. Morphologically deformed variants of *aconitus* and *minimus* adults are described. *Anopheles culicifacies adenensis* and *jeyporiensis* var. *candidiensis* are synonymized. The junior primary homonym *listonii* Liston, is necessarily considered a rejected name. *Pyretophorus jeyporensis* Theobald is considered a junior secondary homonym of *Anopheles jeyporiensis* James. The authorship of the species previously cited as *brahmachari* Christophers by most writers is corrected to McKendrick and Christophers. The name *aconita* var. *merak(cohesia)* is considered an available name and shown to be a synonym of *flavirostris* instead of *minimus*. Lectotypes are designated for *adenensis, albirostris, christophersi, culicifacies, formosaensis I, jeyporensis* and *listoni*.

Hybridization experiments between *aconitus* and *minimus* show that they are well established species with considerable genetic incompatibility.

Faran based his taxonomic revision of the Albimanus Section on a study of 14,792 specimens of this exclusively Neotropical group. In the revision 14 species are recognized in this section, of which individually reared specimens were available for 11 (only for *galvaoi* and *rondoni* were no larvae or pupae available). For the 2 medically most important species (*albimanus* and *aquasalis*), abundant individually reared material from almost their entire geographic range was examined, permitting this analysis of intra- and interpopulational variation within these 2 species.

An attempt has been made to assemble the species into distinct monophyletic groups on the basis of correlated characters in the adults and immatures. The section is divided into 2 groups, the monotypic Albimanus Group and the Oswaldoi Group. The Oswaldoi Group is divided into 2 subgroups, the monotypic Triannulatus Subgroup and the Oswaldoi Subgroup, further divided into the Oswaldoi Complex of 9 species and the Strodei Complex of 3 species. The Oswaldoi Complex contains *oswaldoi, galvaoi, noroestensis, aquasalis, ininii, anomalophyllus, rangeli, trinkae* and *nuneztovari*. The Strodei Complex contains *strodei, rondoni* and *benarrochi*. Material available, each species in all stages (male, female, larva, pupa) is described in standard detail, illustrated and keyed.

The larvae and pupae of the Albimanus Section occur primarily in ground water habitats. All the species breed in fresh water, except for *aquasalis* and often *albimanus* which are often found in brackish water. The females feed predominantly on large mammals. The adults are active either crepuscularly or nocturnally; *triannulatus* is the only species reported to bite occasionally during the day.

Two species, *albimanus* and *aquasalis*, are major vectors of malaria in Central and South America and the islands of the Caribbean. *An. nuneztovari*

is the primary vector of malaria in western Venezuela and northern Colombia and possibly a vector in Suriname. *An. triannulatus, strodei* and *noroestensis* have been implicated in the transmission of malaria, since they have been found naturally infected. *An. rangeli* has been suspected of transmitting malaria in Ecuador. Two viruses, Venezuelan Encephalitis virus and Tlacotalpan virus, have been isolated from *aquasalis* and *albimanus* respectively. Nothing is known about the medical importance of the remaining species.

c. Illustrations

The scientific illustrator staff continued to provide illustrative support to a wide variety of studies including work on *Anopheles, Culex, Aedes* and *Tripteroides*. These include completed illustrative for short articles published during the year and for the revisions of the Leucosphyrus Group of *Anopheles* and the Spissipes and Ocossa Groups of *Culex (Melanoconion)*. Special effort was given to illustrating the borrowed types and other material of African *Aedes (Stegomyia)*.

d. Scientific Literature

Approximately 100-150 folders were typed and filed through the year. Several selected references from the MEP files were provided collaborating specialists and institutions.

e. Participation in Scientific Activities

Due to restrictions on travel funds, only Dr. Faran was able to attend a single meeting during the year. He presented a paper jointly authored by Faran, Klarman and Bailey entitled "Application of a Computerized Information Management System (SELGEM) to Medically Important Arthropods (National Museum Mosquito Collection)" to the annual meeting of the American Society of Tropical Medicine and Hygiene. In addition, he taught a course and presented lecture on Medical Entomology and Anopheline vectors to various military groups.

f. Visitors

During the year, 12 visitors signed the guest book in the project. Overseas visitors included Dr. Hector Dourado (Institude Medicina Tropical de Manaus, Brazil), Dr. Jack Peterson (Gorgas Memorial Laboratory, Panama), Dr. Richard F. Darsie (Guatemala, Guatemala), Dr. Joel Margalit (Dept. of Biology, Ben Gurion University, Israel), Dr. Wallace A. Steffan (Bishop Museum, Honolulu, Hawaii), Dr. Jih Ching Lien (Taiwan Provincial Institute of Infectious Diseases, Taipei), Dr. Somthas Malikul and Mr. Kasem Nimtakul (Ministry of Public Health, Malaria Division, Bangkok, Thailand) and Drs. Prida Kocharatana and Thawati Kaoesanit (Regional Malaria Directors, Khon Kaen and Songkla, Thailand).

Dr. Richard Darsie visited the project for a few days to check the larvae of certain North American mosquitoes for use in the project on keys to the mosquitoes of North America, north of Mexico which is a joint project of Drs. Darsie and Ward (WRAIR) and is funded by the American Mosquito Control Association. The key was completed and sent to the printer in 1980 and should be published early in 1981.

g. Consultants

The consultants of the MEP are identified in Appendix 3.

On April 25, 1980, Dr. John N. Belkin passed away. He was a long time consultant and strong supporter of MEP whose help will be sorely missed. He left his entire collection and library on mosquitoes to the Smithsonian Institution. We expect that it will arrive early in 1981.

As discussed earlier, a number of major manuscripts have been completed by our consultants, all of which have involved some degree of support by MEP. These are: (1) the Harrison revision of the Myzomyia series of *Anopheles (Cellia)* now published; (2) the Mattingly revision of certain groups of *Tripteroides*, whose typescript is being final proofed; (3) the Reinert revision of *Paraedes*, genus *Aedes*, which is ready for review and editing.

Late in 1980 the "Taxonomists' Glossary of Mosquito Anatomy" authored by R. E. Harbach and K. L. Knight was published. This work in its earlier stages was supported strongly by SEAMP and MEP, and the final volume still includes many illustrations originally produced by staff artists. The glossary is an attempt to name, define, and illustrate each sclerotized structure of all life stages of the mosquito, as well as list all synonyms of these names. It is a necessary working tool for all workers on mosquitoes.

All consultants have continued to give freely of their time, reviewing manuscripts, answering questions, and generally supporting the work of MEP. We are indebted to them all.

Appendix 1

ACCESSIONS OF THE MEDICAL ENTOMOLOGY PROJECT, 1980

	No. Acc.	Adults	Slides	Other
Inst. Nac. Pesquisas da Amazonas Belem, Brazil	1	3216		
SEATO Lab Bangkok, Thailand	4	636	695	
MEP Field Trips	2	668		496 Vials immatures
USAMRU Brasilia, Brazil	2	456		492 Vials immatures 11 Unmounted adults
NMNH	2	315		313 Vials immatures
L. W. Teler Florida	1	598		
SAIMR Johannesburg, RSA	4	233		194 Vials immatures 8 Egg lots
J. Hayes Texas Tech.	1	331		
D. J. Pletsch Mexico	1	212		13 Lots unmounted adults 5 Vials immatures
WRAIR Washington, D.C.	3	104		43 Egg lots
Cornell University Ithaca, New York	2	88		13 Vials immatures
William Wills Saudi Arabia	2	94		8 Lots unmounted adults
R. S. Panday Surinam	1	44		45 Vials immatures
DVBD, Ministry of Health Nairobi, Kenya	1	86		

	No. Acc.	Adults	Slides	Other
Notre Dame University Notre Dame, Indiana	2	58	22	
CDC Fort Collins, Colorado	2	51	13	2 Lot unmounted adults
NITD Johannesburg, RSA	7	28		28 Vials immatures 22 Egg lots
Yale University New Haven, Connecticut	1			53 Unmounted Adults
National Institute of Virology Johannesburg, RSA	1	39		
University of California Los Angeles, CA	1	16		14 Vials immatures
USDA	4	17		8 Unmounted Adults 1 Vial Immatures
I. Miyagi University of the Ryukyus	1	9	8	
British Museum London, England	3	16		
East African Virus Research Institute Entebbe, Uganda	2	15		27 Egg lots
Vector Control Research Center India	1	2	2	
Institude de Higiene e Medcina Lisboa, Portugal	1	3		
Biosystematic Research Institute Ottawa, Ontario, Canada	1		1	1 Vial immatures
R. A. Barr California	1			1 Egg lot
Pan American Health Organization Washington, D.C.	1	1		

SUMMARY OF ACCESSIONS FROM 1 JAN 1980 TO 31 DEC 1980

56 Accessions (Numbers 793-848)

1,602 Unmounted Immatures
72 Unmounted Adults
741 Slides
7,336 Adults
9,751 Total Specimens

Other Material Received

101 Lots of Eggs to be Reared
23 Lots of Unmounted Adults

Outgoing Material

67 Shipments
37 Involving Specimens

524 Slides
938 Adults
1,462 Total Specimens

Appendix 2

PUBLICATIONS OF THE MEDICAL ENTOMOLOGY PROJECT
Supported in whole or in part by Contract DAMD 17-74-C-4086

Faran, M. E. 1980. Mosquito studies (Diptera: Culicidae) XXXIV. A revision of the Albimanus Section of the subgenus *Nyssorhynchus* of *Anopheles*. Contr. Am. Entomol. Inst. 15(7):1-215. (March)

Sirivanakarn, S. and J. N. Belkin. 1980. The identity of *Culex (Melanoconion) taeniopus* Dyar and Knab and related species with notes on the synonymy and description of a new species. Mosq. Syst. 12(1):7-24. (March)

Sirivanakarn, S. and P. Galindo. 1980. *Culex (Melanoconion) adamesi*, a new species from Panama (Diptera, Culicidae). Mosq. Syst. 12(1):25-34.(March)

Sirivanakarn, S. and S. J. Heinemann. 1980. Description of the hitherto unknown adult and pupa of *Culex (Melanoconion) simulator* (Dyar and Knab), and redescription of its larva (Diptera: Culicidae). Mosq. Syst. 12(1): 41-49. (March)

Huang, Y.-M. and J. C. Hitchcock. 1980. Medical Entomology Studies XII. A revision of the *Aedes scutellaris* group of Tonga (Diptera: Culicidae). Contr. Am. Entomol. Inst. 17(3):1-107. (June)

Peyton, E. L. and B. A. Harrison. 1980. *Anopheles (Cellia) takasagoensis* Morishita 1946, an additional species in the Balabacensis Complex of Southeast Asia (Diptera: Culicidae). Mosq. Syst. 12(3):335-347. (Sept.)

Harrison, B. A. 1980. Medical entomology studies XIII. The Myzomyia series of *Anopheles (Cellia)* in Thailand, with emphasis on intraspecific variations (Diptera: Culicidae). Contr. Am. Entomol. Inst. 17(4):1-195. (Oct.)

Faran, M. E. and C. L. Bailey. 1980. Discovery of an overwintering female of *Culiseta annulata* in Baltimore. Mosq. News 40(2):284-287. (Sept.)

Appendix 3

MEDICAL ENTOMOLOGY PROJECT CONSULTANTS

Dr. Pedro Galindo, Gorgas Memorial Laboratory, P.O. Box 935, APO Miami, FL - New World Culicidae.

LTC Bruce A. Harrison, Department of Medical Entomology, U.S. Army Component, Armed Forces Research Institute of Medical Sciences, APO San Francisco, CA - Oriental *Anopheles*.

Dr. Botha de Meillon, Philadelphia, Pennsylvania.

Dr. J. M. Klein, Centre ORSTOM de Papeete, Tahiti - Oriental Culicidae.

Professor Kenneth L. Knight, North Carolina State University, Raleigh, North Carolina - *Aedes (Finlaya)* and mosquito glossary.

Dr. Peter F. Mattingly, British Museum (Natural History), London, England - African Culicidae and *Tripteroides*.

Mr. J. Mouchet, ORSTOM, Bondy, France - Culicidae.

LTC John F. Reinert, Research Liaison Officer, Armed Forces Pest Management Board, Gainesville, Florida - Genus *Aedes*.

Dr. John E. Scanlon, School of Public Health, University of Texas, Houston, Texas.

Dr. Shivaji Ramalingam, University of Malaya, Kuala Lumpur, Malaysia - *Topomyia, Malaya, Armigeres* and Malaysian Culicidae.

Dr. Graham B. White, London School of Hygiene and Tropical Medicine, London, England - African Culicidae.

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